MISCELLANEOUS INVESTIGATIONS SERIES THE COMMONWEALTH OF PUERTO RICO DEPARTMENT OF THE INTERIOR MAP I-1010 DEPARTMENT OF NATURAL RESOURCES UNITED STATES GEOLOGICAL SURVEY

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## STRATIGRAPHY

The stratigraphy in the San Juan quadrangle consists of Cretaceous and lower Tertiary clastic and volcaniclastic stratified rocks and thin lavas that are unconformably onlapped by unconsolidated to poorly consolidated sand, silt, and gravel of middle Tertiary to Holocene age along the southern border of the quadrangle. Reef limestone, also of middle Tertiary age, occurs in sporadic outcrops, mostly forming prominent hills and ridges that have been deeply excavated by quarrying. The Atlantic Ocean covers the northern third of the quadrangle. Quaternary and possibly upper Tertiary beach, eolian, swamp, and alluvial deposits form most of the land area in the northern half of the quadrangle, except that large parts of Bahia de San Juan and Laguna San José have been arti-

CRETACEOUS TO EOCENE

The oldest formation in the quadrangle is the Guaynabo. It consists of well-bedded volcanic wacke and tuffaceous siltstone interstratified with volcanic conglomerate. These strata, though extensively exposed to the south, are only poorly exposed here. The Martin González Lava Member, which forms an important stratigraphic marker across the Aguas Buenas quadrangle to the south and which is stratigraphically near the middle of the Guaynabo Formation (Pease, 1968b), is only poorly exposed in three small fault slivers near the southern border of this quadrangle. At the type locality of the Martín González Lava Member, in the Gurabo quadrangle to the southeast, Seiders (1971) elevated this member to formation status and assigned the rocks above the lava, here included with the Guaynabo Formation, to the Frailes Formation. The Leprocomio Siltstone Member of the Guaynabo Formation is a ridge former of calcarous-tuffaceous siltstone. It is well exposed along the northern border of the Aguas Buenas quadrangle, but it is exposed in the San Juan quadrangle only in one small outcrop just west of Colegio Sra de la Providencia. This member lies at the top of the Guaynabo Formation in the Aguas Buenas quadrangle according to Pease (1968b); Seiders (1971) called it the Leprocomio Mudstone Member at the top of

The Monacillo Formation is a sequence of mudstone, conglomerate, and tuffaceous siltstone that is approximately 400 m thick in the northwest corner of the Aguas Buenas quadrangle, but it thins rapidly eastward and apparently pinches out in the southwest corner of the adjacent Carolina quadrangle to the east. Much of the mudstone and conglomerate is reddish gray or purplish gray due to hematitic iron-oxide coating and manganese staining, an indication that the source material was eroded from an oxidizing environment. A shallow-water marine environment of deposition is suggested by interlayers of gray thin-bedded tuffaceous sandstone and siltstone, as well as by the presence of the Trujillo Alto Limestone Member at the top of the Monacillo and several thin lenticular-limestone lenses within the formation. Like the underlying Guaynabo Formation, the Monacillo is poorly exposed in the San Juan quadrangle and is largely covered by urban housing. The Monacillo rests conformably on the Leprocomio Siltstone Member in exposures along the northern border of the Aguas Buenas quadrangle.

The Trujillo Alto Limestone Member is a lenticular reef limestone that lies near the top of the Monacillo Formation mostly in the northeast corner of the Aguas Buenas quadrangle. The only outcrops of the Trujillo Alto in the San Juan quadrangle are exposed in a tilted and rotated fault block that forms a horst in Tertiary rocks east of the northwest-trending fault in Quebrada Guaracanal. Numerous shallow excavations indicate that the limestone has been quarried. The Guaracanal Andesite is very poorly exposed in a band along the southern border of the quadrangle east of the fault along Quebrada Guaracanal. The formation was named for exposures along this valley just to the south in the Aguas Buenas quadrangle. The Guaracanal Andesite is characteristically distinctive purplish gray. It is a pyroclastic unit, the source of which appears to be a vent in the northern part of the Aguas Buenas quadrangle (Pease, 1968a, p. 41). The Guaracanal rests with angular unconformity at one locality on beds of the Guaynabo Formation, but, where the Monacillo Formation is present, the contact appears to be conformable (Pease 1968a, p. 41). The Rio Piedras Siltstone was "named for a sequence of well-stratified mostly fine-grained tuffaceous epiclastic rocks that are well exposed in the Montes de Hatillo south of the town of Río Piedras in the San Juan quadrangle. The type section of this formation is in a large quarry just west of Highway 181 in the San Juan quadrangle (60,940 m N., 195,360 m E. to 60,360 m N., 195,150 m S.)" (Pease, 1968a, p. 44). The Río Piedras Siltstone rests with apparent conformity on the

Guaracanal Andesite where present, but in the western part of the quadrangle, the Guaracanal is absent and the Río Piedras rests with angular unconformity on the Monacillo Formation. The Rio Piedras Siltstone is divided into four members in the Aguas Buenas quadrangle. These are a basal siltstone member, a limestone member, a coarse volcanic rock member, and an upper member. The limestone member is restricted to the Aguas Buenas quadrangle, and the coarse volcanic member becomes finer grained and contains increasing numbers of siltstone interbeds toward the north. It was, therefore, not possible to carry these members into the San Juan quadrangle. In this quadrangle the Río Piedras consists of dark-gray to grayish-black thin-bedded to laminated calcareous siltstone and very fine grained calcareous sandstone alternating with thick-bedded to massive coarse volcanic sandstone and pebble conglomerate or pebble breccia. A thickness of at least 1000 m is exposed in the quadrangle and the top is The late Paleocene Foraminifera fauna identified by Jeremy Reiskind, (Pease, 1968a, p. 46) was collected from the fossil locality shown in the

## southwest corner of the map. OLIGOCENE TO HOLOCENE

The formations of Oligocene and Miocene age are better exposed in the adjacent Bayamon quadrangle to the west (Monroe 1973a), and their relations to rocks of similar age in other parts of Puerto Rico are fully discussed by Monroe (1973b). The San Sebastían Formation, which rests unconformably on older Tertiary strata in the San Juan quadrangle, consists mostly of varicolored sandy clay with some conglomerate and is mapped only in the southwest corner, west of the Río Piedras. The Mucarabones Sand, which conformably overlies the San Sebastian, consists mostly of quartz-rich sand and some gravel in the San Juan quadrangle; it appears to be stratigraphically equivalent to the Lares Limestone and lower part of the Cibao Formation exposed to the west in the vicinity of Corozal (Monroe, 1973b).

The Cibao, Aguada, and Aymamón Formations are a conformable sequence of mostly calcareous strata, the basal formation of which, the Cibao, apparently intertongues eastward with the Mucarabones Sand (Monroe, 1973b). The Cibao Formation, consisting of chalk, soft limestone, and sandy clay, and the Aguada Limestone, consisting of more resistant calcarenite and chalky limestone, form the belt of low but rugged hills across the west-central part of the quadrangle and include a few small knobs to the west. The Aymamon Limestone is exposed only in the vicinity of the east end of the Caño de Martín Peña; this almost pure massive limestone has been extensively quarried.

The Mucarabones Sand and San Sebastian Formation grade eastward into varicolored clay, silt, and sand deposits that are indistinguishable from each other and from younger alluvial deposits. Most of the strata exposed east of the Rio Piedras and south of Laguna San Jose are mapped together as older alluvial deposits. They appear to be stratigraphically equivalent to the San Sebastian Formation and Mucarabones Sand in their lower part where they rest unconformably on the Río Piedras Siltstone. The upper part includes alluvial-fan deposits. Alluvial fan deposits, distinguished largely on a morphologic basis,

have been mapped separately west of the Río Piedras. These deposits consist of varicolored clay, silt, and sand derived from the Mucarabones Sand and San Sebastían Formation and deposited by short streams originating in the hills in the southern part of the quadrangle. The younger Quaternary and Holocene deposits, eolianite, silica sand, alluvium, swamp deposits, beach deposits, and artificial fill, are adequately described in the description of map units.

## **STRUCTURE**

Cretaceous and lower Tertiary rocks exposed in the hills in the southern part of the quadrangle are unconformably onlapped by gently northward-dipping younger Tertiary and Quaternary strata that compose most of the land area in the quadrangle. The rocks beneath the unconformity form the northeast limb of a northwest-plunging anticlinal nose that has been severely disrupted by faulting. The northeast limb of this anticlinal structure is clearly shown on the small-scale map of the region (Pease, 1968a, pl. 1) by the distribution of faulted segments of the Leprocomio Siltstone Member of the Guaynabo Formation. The southern limb apparently has been cut out along the Tortugo fault that extends in west-northwest direction across the northwestern part of the Aguas Buenas quadrangle. Although not so clearly apparent, the northwest-plunging anticline is also demonstrated by the arcuate pattern of the Rio Piedras Siltstone on this map of the San Juan quadrangle. Two northwest-trending wrench faults cut the Cretaceous and lower Tertiary rocks and apparently are buried beneath the younger sediments on the north. The one in the southwest corner of the quadrangle extends southeastward into the Aguas Buenas quadrangle where it joins the Leprocomio fault. The Leprocomio fault, which is the eastern of the two wrench faults in the San Juan quadrangle, is also one of the principal faults of the great northern Puerto Rico fault zone (Briggs and Pease, 1968). Apparent direction of movement on the western fault is left lateral and on the Leprocomio fault is right lateral. The entire block between the two faults appears to have moved several kilometers to the west relative to the rocks on either side.

A third northerly trending arcuate fault separates the Monacillo from the Guaynabo Formation and is cut off on the north by the Leprocomio fault. This fault has an apparent displacement of 6500 m. The Monacillo apparently was thrust under the Guaynabo along this fault during northwestward movement along the two wrench faults.

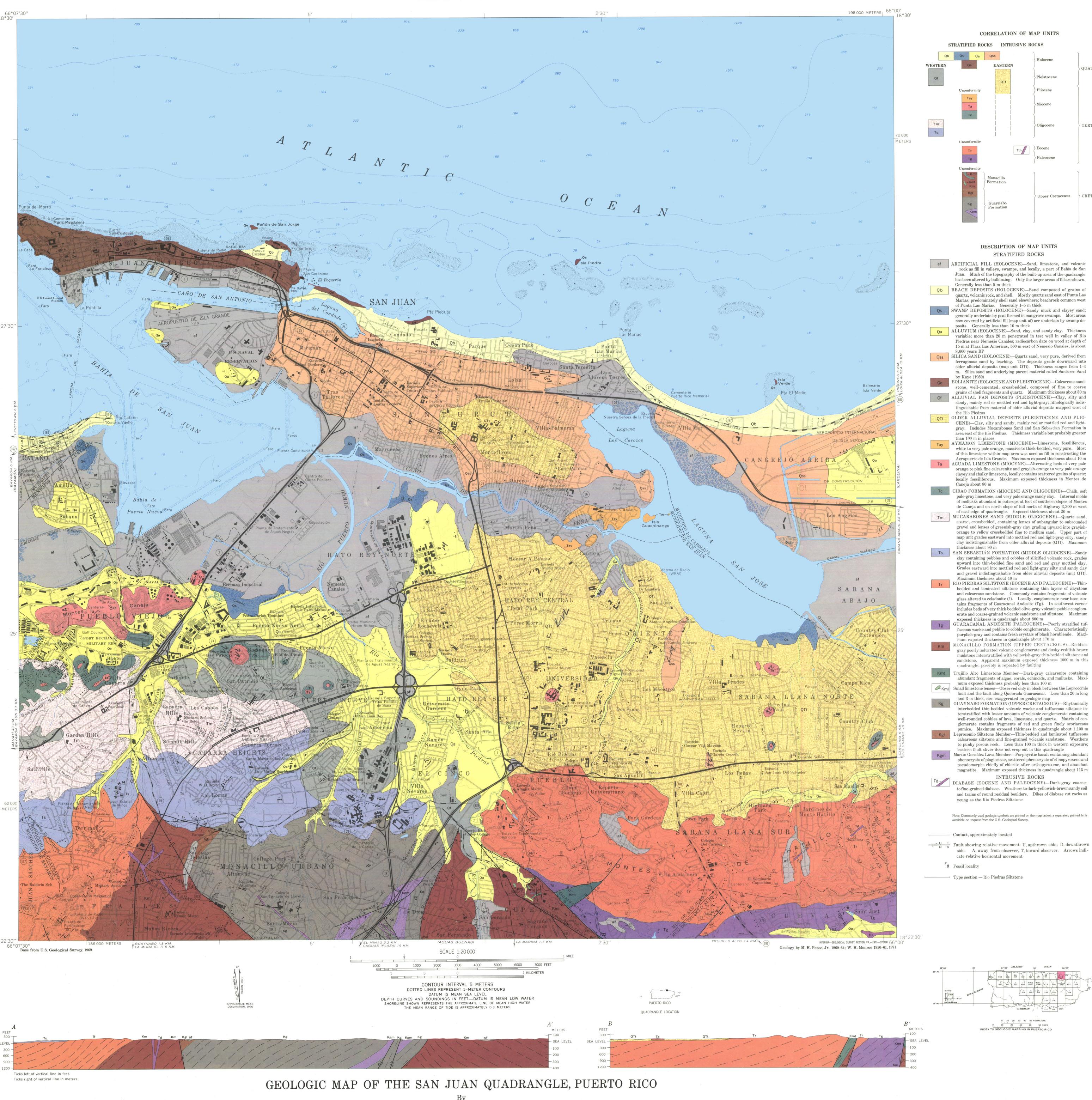
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QUATERNARY

TERTIARY

CRETACEOUS

Pleistocene

Pliocene

Miocene

Upper Cretaceaus